What if Ageing was the Only Investment: the Role of Credit Markets Imperfections and the Age Profile of Earnings

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Abstract

Does it pay relatively more to be an old age worker in one country with respect to another? The short answer is yes, and substantially. While Germany, UK, Sweden and the EU-15 average all display an inverted-U age profile of earnings, such that earnings typically peak for workers in their fourties or fifties, Italy and Belgium are economies characterized by a monotonically increasing age profile of earnings.

The contribution of this paper is to rationalize this evidence relying only upon differences in credit access imperfections. The main result is that economies characterized by well functioning credit markets have an inverted-U age profile of earnings, while imperfect credit markets determine a delay in the undertaking of investment opportunities and workers’ earnings monotonically increasing with age.

This approach also provide two additional implications. The first is that in economies where the age earnings relationship is non monotonic (reversed U), the entrepreneurial class is younger than in economies where earnings monotonically grow with age. The second implication is that, in the cross country comparison, there should be relatively more job-to-job mobility in the age class where more entrepreneurs come from.

This rationalization also carries an interesting policy implication: if we are concerned with increasing the average wage and fostering aggregate productivity, it does not suffice to reform labor market institutions if credit markets imperfections are still present.

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1 Introduction

Does it pay relatively more to be an old age worker in one country with respect to another? The short answer is yes, and substantially. The evidence recently released by Eurostat (Figure 1) shows an interesting difference in the relationship between age and employees’ earnings across different European countries: Germany, UK, Sweden and the EU-15 average all display a non-monotonic behavior of earnings in age, such that earnings peak for workers in their forties or fifties to fall at a later stage. Italy, Belgium and the Netherlands are instead characterized by earnings that are monotonically increasing in age. Moreover, the countries that display a monotonically increasing age profile of earnings also feature lower average wage. This simple cross-country difference is interesting in its own right. It is also relevant from the point of view of welfare analysis: in a society where workers have to wait until old age to "cash" their productivity, it is vital to have well-functioning credit markets. In the presence of credit market imperfections, this delay in earnings can be very costly for workers coming from low-income households and it can be detrimental to social mobility.

Figure 1

The contribution of this paper is to use the simplest form of credit access imperfections to rationalize this and other related evidence and provide a different policy implication. The reader should have in mind an economy where each individual has a finite lifetime and, in each period of his life, he works and decides how to allocate his income between consumption and savings. By the time agents becomes middle aged, some have the luck (or the skills) to face an investment opportunities, i.e. a production technology. These technologies produce capital but they depreciate over time, i.e. they become progressively
less productive as time goes by. So middle age agents have more productive technology at their disposal than old age individuals.

The capital they produce is then employed in the production of output. The production of output employs not only capital but also labor. Labor is not treated as a completely homogeneous input though: two units of labor coming from workers of two different age classes are treated as different inputs.

Agents decide whether to seize these investment opportunities for capital and become entrepreneurs or remain workers and be employed in the production of output. Agents face the choice between remaining a worker and becoming an entrepreneur up to two times in their lifetime. When they become old age, they will once again ponder whether to become an entrepreneur or not. The only difference is that the investment opportunity at their disposal will be less productive.

In principle, agents should decide to become entrepreneurs anytime the investment opportunity is sufficiently productive to justify the amount of upfront funds it requires. In reality though this trade-off is not the only determinant of investment decisions. These decisions also depend on how well capital markets work. If there were no credit market imperfections, any positive net present value opportunity would be funded until the aggregate supply of funds/savings is exhausted at the prevailing equilibrium interest rate. In this case, while productive investment opportunities are undertaken, a general equilibrium effect on wages also takes place. Instead, as more investment opportunities are undertaken by individuals in a given age class, two effects take place: first, wages in the economy as a whole increase as diminishing returns loosen up, since more production technologies are operated and the marginal productivity of workers increases; second, there is a relatively stronger effect for those workers belonging to the age class in which entrepreneurs come from: as many people from a given age class become entrepreneurs, less workers of that class become available for firms. This relative scarcity increases their wage with respect to the other age classes.

In conclusion, two are the effects of a well functioning credit market: first, the economy becomes more productive and the average wage increases; second, the wage increases relatively more for those workers that belong to the age class where most of the entrepreneurs come from. These workers typically belong to the middle age group, when investment opportunities are most productive. Therefore the age earnings relationship is non monotonic: wages first grow from young to middle age, they fall again when workers become old age.

If, instead, credit markets were imperfect, unable to provide credit in excess to some small proportion of the net present value of the investment opportunities, it may very
well be the case that a big chunk of the agents is not able to undertake valuable investment opportunities and become entrepreneurs. Many potential entrepreneurs are credit constrained, they remain workers until they accumulate enough savings to rely less on external credit. Therefore only few new investment opportunities are undertaken by middle age workers, the average wage in the economy does not change. Individual wages mainly increases as human capital is accumulated by workers that become progressively more experienced as they age. The entrepreneurial class becomes older on average and wages monotonically increase with age.

Two are the main assumptions behind the results highlighted above: first, the labor market is segmented by age classes, i.e. a worker in his forties is considered a different input with respect to a worker with similar qualification but in his thirties; second, the timing of investment matters. Investment opportunities depreciate over time if they are not undertaken when they first materialize.

There are two additional implications of this approach, beside what it has to say regarding the age earnings relationship. The first implication is that in economies where the age earnings relationship is non monotonic (reversed U), the entrepreneurial class is more concentrated in one age class, while in economies where earnings monotonically grow with age the entrepreneurial class is more uniformly distributed across different age classes. Prat et al. (2006) provide some evidence in support of this claim comparing the age profile of the CEO’s of the top 40 Italian firms and the top 40 US firms. While the average ages are quite close, 58 in Italy and 56 in the US, in the US most CEO’s are between 50 and 60, in Italy there are 20 CEO’s over 60 and 13 in their forties. The second implication is that, in the cross country comparison, there should be relatively more turnover in the age class where more entrepreneurs come from. Measuring this labor market turnover by job-to-job mobility per age class (measured by percentage of job changers over employees in given age class) and tenure on the job we find that: when earnings grow monotonically with age, workers tend to have a longer tenure in their job for any age class (Figure 2).
and job-to-job mobility is lower for middle aged workers (Table 1)

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<th>age</th>
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<td>7.03484</td>
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Source: European Labor Force Survey 2005
Author’s Computations

Table 1

The contribution of this paper is to stress the importance of credit market access in rationalizing the cross-country difference in the age profiles of earnings and some other stylized facts regarding job tenure, job-to-job transitions and composition of the entrepreneurial class. This paper does not wish to rule out the traditional - common wisdom - explanation for this evidence, that is based on labor market institutional differences and rigidities. But the policy perspective this paper puts forward is nonetheless important. The role of labor market imperfections may very well be important but, as this paper argues, even the most flexible and competitive of the labor markets could not resolve the cross country difference in the age profiles of earnings. Therefore, the policymaker interested in rewarding workers when they are the most productive, fostering capital accumulation and aggregate productivity, should also aim to ease credit market imperfections. Reforms
should tackle both labor and credit markets imperfections, or run the risk of being ineffective in the solution to the puzzle this evidence presents. The alternative stays between a joint reform or no reform, and nothing else.

2 The Economy Setup

2.1 Workers and Entrepreneurs

We present our analysis in the context of a production economy with two goods, capital and output, and overlapping generations living for three periods: young \((y)\), middle \((m)\) and old age \((o)\). We define generation \(t\) to be the set of all individuals born at the beginning of period \(t\) and endowed with the amount of labor, \(L_t = 1\). Generation \(t\) leaves the economy at the end of period \(t + 2\). Every generation consumes in each period of life the amount \(c_{it}\), \(i = y, m, o\), representing the units of consumption in period \(i\) by generation \(t\). Generation \(t\) utility function, \(U_t\), is defined as:

\[
U_t = u(c_{yt}) + u(c_{mt}) + u(c_{ot})
\]

where \(u(\cdot)\) denote the utility extracted from consumption. Maximizing (1), generation \(t\) faces three different age specific budget constraints. When young, agents can only be workers:

\[
c_{y,t} = w_{y,t} - s_{y,t}
\]

where \(w_{i}(t)\) \(i = y, m, o\) represents the wage per worker of age \(i\) and \(s_{it}\) savings.

At the end of their youth and before becoming middle-aged, measure \(\eta \in (0, 1)\) of agents receive (randomly) an investment opportunity of quality \(j\). Then each of these agents must decide to remain a worker or become an entrepreneur. If he decides to remain a worker, he faces the following budget constraint when he is middle aged:

\[
c_{m,t}^w = w_{mt+1} + R_{t+1} \cdot s_{yt} - s_{mt}
\]

where \(R_t\) is the interest factor (one plus the interest rate) paid on savings at \(t\). If instead an agent becomes an entrepreneur and starts project \(j\), he invests his savings \((s_{yt})\) and receives profits \(\pi^j_{mt}\) when middle aged. His budget constraint in this case is:

\[
c_{m,t}^e = \pi^j_{m,t+1} - s_{m,t}
\]
Finally, at the end of their middle age and before becoming old, measure $\eta \in (0, 1)$ agents receive (randomly) an investment opportunity of quality $j$. Once again each of these agents must decide to remain a worker or become an entrepreneur. Analogously to the previous case, when workers they face the standard budget constraint:

$$c_{o,t}^w = w_{o,t+2} + R_{t+2} \cdot s_{m,t}$$

while some face an investment project and may choose to become entrepreneurs facing:

$$c_{o,t}^e = \frac{j}{\sigma_{o,t+2}}$$

2.2 The Technologies of the Economy

The economy is endowed with two production activities. The first activity is the production of capital. There are measure $(2\eta)$ of potential entrepreneurs in the economy in any given period, each of them endowed with a project $j \in [0, 1]$ that can be started by paying the upfront fixed cost:

$$F^j \sim U(F, \bar{F})$$

so that she can produce $\xi_{z=(m,o)}$ units of capital, depending on the age class of the entrepreneur and valued at the market price $q$:

$$\xi_{z=(m,o)} \cdot q$$

The entrepreneur eventually keeps the profits of the project defined by:

$$\pi^j_z = \xi_{z=(m,o)} \cdot q - R \cdot F^j$$

where $R$ is the interest rate paid on savings. For the sake of simplicity but without loss of generality, I will assume that there is a storage technology producing $R$ units of output in any unit of input. This technology pins down the equilibrium interest rate $R$. I also make the additional assumption that the timing of the investment opportunities also matters. In particular:

$$\xi_m > \xi_o$$

that implies that projects undertaken by younger entrepreneurs are more productive, for any given $F^j$, than the ones undertaken by elder entrepreneurs. This is equivalent to assuming that investment projects depreciates over time, becoming less and less productive as time goes by or, equivalently, one could think that all projects are in principles equally productive but, the sooner an entrepreneur starts an investment projects, the more she
can benefit from it during her lifetime as the present value of all profits coming from the project is increased by an early undertaking.

Once produced, capital is employed in the production of output $y_t$ according to a continuous and differentiable constant returns to scale function in capital, $k_t$, and three labor inputs, $l_{it} \ i = y, m, o$, satisfying the law of diminishing returns to single factors:

$$
g'_z = \{k_t, l_{yt}, l_{mt}, l_{ot}\}$$

The assumption in (8) that the labor market is segmented in three age classes (young, middle age and old) is made to capture the fact that workers with similar qualifications are ordered and distinguished by their experience when they apply for jobs. I also assume that there is complementarity among workers of different age classes ($g_{i,t} > 0, i \neq j$). This ensures that, as one type of labor input becomes relatively scarcer, its marginal productivity increases and so it becomes costly for output production to abstain from using one input.

Even though the labor market is segmented by age classes, it is competitive and so is the capital market. Therefore profit maximization implies that all factors are rewarded according to their marginal productivity:

$$q_t = g_{k_t}$$

$$w_{i,t} = g_{l_{it}}, i = y, m, o$$

### 2.3 Credit Markets

We take a simple approach to modelling credit markets imperfections, as in [4], [8] or [9], by assuming that when an entrepreneur goes to apply for credit, creditors are willing to lend only up to share $\alpha$ of the proceeds of the investment project:

$$\alpha \cdot (\xi_z \cdot q)$$

where

$$\alpha \in (0, 1]$$

Assumption (9) is important because entrepreneurs have to put up the amount $F^j$ before starting project $j$ and, when they run out of internal funds ($R \cdot s$), they have no choice but accessing the credit market.
2.4 Market Equilibrium: Definition

The market equilibrium is defined by choice vector \((c_{it}, i = y, m, o)\) and price vector \((q_t, w_{i,t}, i = y, m, o)\) such that:

1. agents optimize
   \[
   (c_{it}, i = y, m, o) \in \arg \max U_t \\
   \text{s.t. } (2), (3), (5), \forall t
   \]

2. good market clears
   \[
   c_{yt} + c_{mt-1} + c_{ot-2} + \int_0^{j_m} F^j dj + \int_0^{j_o} F^j dj = y
   \]

3. capital market clears
   \[
   k_t = \eta \left[ \int_0^{j_m} \xi_m dj + \int_0^{j_o} \xi_o dj \right] \tag{10}
   \]

where we have that the capital stock is the sum of capital production by entrepreneurs of both middle and old age. The assumption that capital fully depreciates from one period to the next does not affect the proposed results.

3 The Equilibrium with Perfect Credit Market

Consumer optimization delivers that an agent chooses to be an entrepreneur instead of a worker if it satisfies the following inequality:

\[
\pi^j z \geq w_z
\]

which, by (7), results into:

\[
\frac{\xi z \cdot q - w_z}{R} = F^j \leq F^j \tag{11}
\]

(11) defines the threshold fixed cost \(F^j\) below which a project has positive value, net of the wage as an outside option. With perfectly working credit markets, i.e. \(\alpha = 1\) in (9), all those projects \(j < j_z\) such that \(F^j \leq F^j\) should be undertaken. I rule out by assumption the fact that the economy runs out of aggregate savings \(S_t\), i.e. \(k_t > S_t\) where

\[
S_t = s_{yt} + s_{mt-1} \cdot (1 - j_m \eta) + s_{ot-2} \cdot (1 - j_o \eta)
\]
It is worthwhile to comment further on (11). The number of projects undertaken in equilibrium depends on the relative price of capital $q$ over the $w_z$. There is a double general equilibrium effect of investment activity: the more investment projects are undertaken, the lower is the productivity of capital and its price $q$. But this also increase the productivity of all labor inputs in the economy, boosting the average wage.

It is possible to spell out the effect of capital accumulation on wages even further. Since

$$\xi_m > \xi_o$$

by assumption, we have that more agents from the middle age class will choose to become entrepreneurs with respect to agents in old age, i.e.

$$F_o < F_m$$  \hspace{1cm} (12)

As more entrepreneurs are coming from middle age instead of from old age, this creates a relative scarcity of middle age workers in the economy. This scarcity will in turn be priced so that $w_m > w_o$. The age profile of earnings will thus be an inverted U-shape

4 The Equilibrium with Imperfect Credit Markets

When credit markets are imperfect agents can not borrow up to the PV of future proceedings. An entrepreneur wishing to invest thus borrows

$$F^j - s$$

necessary to start project $j$. Due to credit market imperfections he is only provided up to:

$$\alpha \cdot (\xi_z \cdot q)$$

with $\alpha < 1$. Therefore, an agent becomes an entrepreneur only if inequality (11) and

$$\alpha \cdot (\xi_z \cdot q) \geq (F^j - s)$$  \hspace{1cm} (13)

are both satisfied. The interpretation of (13) is that only projects that require an amount of borrowing by their entrepreneur smaller than what credit markets are willing to supply can be undertaken. This amount of credit is in turn a function of credit market imperfections, indexed in the present context by $\alpha$. 

9
When \( \alpha \) becomes small enough, only very productive potential entrepreneurs - the ones endowed with low \( F^j \) - will be able to undertake their project when middle age. Most of the potential entrepreneurs will be forced by the tightness of the credit market to wait until the time they will be older, when they have enough savings to rely as little as possible on the credit market.

In the presence of credit markets imperfections, there is positive measure of investment projects like \( \widehat{j} \) such that:

\[
\frac{\xi_z \cdot q - w_z}{R} \geq F^\widehat{j} \geq \alpha \cdot (\xi_z \cdot q) + s
\]  

(14)

The projects satisfying the double inequality in (14) are productive enough to have positive net value, but fail to be funded because of the imperfections in the credit market. Thus, it becomes optimal for agents endowed with these projects (or the possibility to receive these projects in the future) to accumulate savings so that

\[ s_m \gg s_y \]

Looking at inequalities (14), it is straightforward to show that more investment projects will be undertaken by old age entrepreneurs as long as

\[ \alpha \cdot (\xi_o \cdot q) + s_m > \alpha \cdot (\xi_m \cdot q) + s_y \]

which reduces to:

\[ s_m - s_y > \alpha \cdot (\xi_m - \xi_o) \cdot q \]

(15)

Inequality (15) tends to be more easily satisfied the worse are credit markets imperfections. Therefore, for sufficiently bad credit markets imperfections, we have that the entrepreneurial class come proportionately more from the old age class, i.e.

\[ (j_o)_{ICM} > (j_m)_{ICM} \]

This fact has, once again, two general equilibrium effects on wages. The first is that the average wage is now lower with respect to the case of perfect credit markets because capital production is reduced by credit markets imperfections. The second is that, as relatively more entrepreneurs come from the old age rather than from middle age, this creates a relative scarcity of old over middle age workers. This in turn boosts the relative wage of old worker with respect to middle age worker so that \( w_o > w_m \) and the economy displays a **monotonically increasing** Age profile of earnings.

Two additional "spill over" implications to discuss: Job Tenure and Job-to-Job Mobility.
References


